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RESEARCH ARTICLE

Examining Human-Nature Relationships Through the Lens of Reciprocity: Insights from Indigenous and Local Knowledge

Two lenses for exploring relationships between seabirds and fishers: Unveiling reciprocal contributions

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Abstract

1. Reciprocal relationships between fishers and marine life have been documented in Indigenous fishing contexts, but there are few case studies that describe the mechanisms of such relationships, and even fewer that explore other contexts, such as that of artisanal fishers in Latin American countries.
2. We studied the artisanal hake fishery in the sub-Antarctic channels of Chilean Patagonia, a global hotspot for albatross and petrel diversity. We aimed to uncover nature's contributions to hake fishers and, reciprocally, the potential fishers' contributions to marine life with a particular emphasis on seabirds. We adopted a bifocal observational strategy. From a human perspective, ethnographic methods (e.g., semi-structured interviews) are analysed with Nature's Contributions to People and reciprocal contribution frameworks. From the seabirds' view, we assessed offal consumption through experimental and observational methods. We randomly threw offal items into the sea and observed the seabird responses (whether they consumed offal).
3. Hake fishers' relationships with the marine environment are multidimensional, particularly with seabirds. Based on fishers' perceptions, we identified four key contributions of seabirds to humans: they serve as value indicators of fishing distribution and concentration areas, offer companionship and recreation during fishing activities, enhance scenic emotionality through the presence of albatrosses and assist in the function of sea cleaning. In reciprocal contributions, artisanal fishers viewed hake offal as a beneficial food source for the seabirds, especially the liver. Fishers described that fishing in the right way can reduce bycatch and effort.

4. The fishers' main contribution to seabirds is through offering them the offal of hake catches. We observed that seabirds consumed hake liver 99% of the time, while they consumed stomach less frequently (24%). We identified that southern giant petrels and black-browed albatrosses consumed more liver, while kelp gulls ate more stomach. The liver comprises 51.6% fat, essential for high trophic level marine predators such as black-browed albatrosses.
5. Adopting reciprocal contributions and NCP served as a catalyst for understanding fishers' positive actions but also is a promoter to research multiple views of nature–human relationships in fishing settings. Values of nature, like reciprocity, could enrich ecosystem-based management strategies.

KEYWORDS
artisanal fisheries, ecosystem-based fisheries management, fish offal, Nature's contributions to people, Patagonia, reciprocity, values of nature

1 | INTRODUCTION

Artisanal fisheries, small-scale practices deeply embedded within local communities, play a pivotal role in social-ecological systems, particularly in the Global South. Employing 90% of the world's fish workers and accounting for at least 40% of worldwide fish harvests, these fisheries are essential for food security, income and employment (FAO, 2023). Most of their catch is for human consumption, involving fisher households, low-energy use and minimal mechanization on small vessels (Suazo et al., 2013). Beyond economic contributions, artisanal fisheries are integral to biocultural systems, often involving diverse values of nature (e.g., reciprocity), aspects frequently overlooked by policymakers and fisheries managers (Booth et al., 2023; Stephenson et al., 2014).

Artisanal fishers accumulate ecological knowledge, values and perceptions, developing diverse connections with the marine environment through oral storytelling and hands-on experiences (Pita et al., 2016). Some experiences can evoke negative perceptions, like encounters between fishers and sea lions but other experiences, like those with seabirds, can stimulate positive values (Suazo et al., 2024). For instance, understanding species behaviours, fish movements and species indicators of productive areas can lead to potential reciprocal contributions (García-Quijano & Valdés Pizzini, 2015; Ojeda et al., 2022; Salas et al., 2015). These relationships can be examined using biocultural approaches that consider ecological and social methodologies.

In this context, the framework of reciprocal contributions encompasses actions, interactions and experiences between people and other components of nature that result in positive contributions through different scales and dimensions, addressing various dimensions underexamined by the concept of ecosystem services in fisheries research (Ojeda et al., 2022). This framework recognizes that reciprocal practices are intertwined with multiple aspects of human life, manifesting through narratives, actions and cultural guidelines (Ojeda et al., 2022). For example, in a biophysical dimension, the cooperation between fishers and dolphins for improving fish catches has been documented in Brazil and Myanmar. Such interactions, however, have been jeopardized by the displacement of Indigenous and local communities (Van der Wal et al., 2022). Despite the historical damages caused by colonization, many of these reciprocal relationships remain active in Indigenous fishing practices and potentially in other fishing contexts like artisanal fisheries (Ojeda et al., 2022).

Frameworks like Nature's Contributions to People (NCP) help clarify the diverse ways people value nature (Pascual et al., 2023). The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) proposed Nature's Contributions to People to reframe ecosystem services. NCP emphasizes the benefits people obtain from nature and incorporates different worldviews by offering context-specific and generalizing perspectives (Díaz et al., 2018; Pascual et al., 2017). For instance, the generalizing perspective includes 18 categories based on the multiple nature's contributions to people (Díaz et al., 2018). In general, this approach recognizes the central role that culture plays in defining all links between people and nature.

Applying Nature's Contributions to People (NCP) and reciprocal contributions (RC) frameworks fosters a comprehensive exploration of diverse valuations, like reciprocity, and allows for practical interdisciplinary methods to bridge the gap between social and ecological sciences. The IPBES 'Values Assessment' report (IPBES, 2022) highlights the importance of embracing a broad spectrum of valuations beyond traditional ecological and economic considerations, acknowledging the influence of biocultural values on worldviews and decision-making processes. While such values are integral to Indigenous marine governance strategies, their application in other areas, such as artisanal fisheries, remains limited in fisheries management. Certainly, ecosystem-based management strategies have aimed for a more holistic view, but integrating ecological and cultural perspectives still represents a significant research gap in artisanal fisheries (Long et al., 2017).

Focused on artisanal hake fishers in Chilean Patagonia (hereafter hake fishers) and their interactions with seabirds, this study examines values of nature, like reciprocity, between hake fishers and marine life by applying NCP and RC frameworks. The artisanal fishery of *Merluccius australis* is a food source for seabirds by providing offal discharges (e.g., gonad, liver and stomach). The hake offal could be considered a biophysical indicator of the seabird relationships with fishers (Suazo et al., 2013). To comprehensively understand these relationships, our interdisciplinary research raises biocultural and ecological questions: What are nature's contributions to hake fishers, and reciprocally, what are the fishers' perceptions of their contributions to marine life, with a specific focus on seabirds? How does the probability of seabird consumption vary depending on offal hake items like gonad, liver and stomach? From this, we discussed some value indicators in the relationships between hake fishers and seabirds and briefly examined conflicts around the artisanal hake fishery. We used two observational lenses to investigate the links between fishers and seabirds: the fishers' lens (ethnographic methods) and the seabirds' lens (experimental and observational methods). We then discuss the importance of values of nature like reciprocity and associated indicators for understanding biocultural relationships and informing ecosystem-based management strategies.

2 | METHODS

2.1 | Case study background

Our research focused on the artisanal hake fishery in the Magallanes region of Chile. Southern hake (*M. australis*; hereafter referred to as 'hake') is a demersal fish that inhabits high southern hemisphere latitudes, such as New Zealand and South America (Reyes & Hüne, 2012). This fish distributes between 50 and 800 m in depth with a lifespan of up to 23 years (Cespedes et al., 1996; Reyes & Hüne, 2012). In Chile, the fishery ranges latitudes from 41°28.6′ to 57° S, comprising three political-administrative regions: Los Lagos, Aysén and Magallanes, collectively known as Chilean Patagonia (Figure 1). This macrozone includes oceanic systems, where industrial fishing operates (>5 nm from shore), and estuarine systems (sub-Antarctic channels and fjords), where artisanal fishing occurs (Toledo et al., 2019). This region is a global hotspot for albatross and petrel diversity (Croxall et al., 2012). For instance, the Magallanes region holds six known albatross colonies that host over 20% of the global breeding population of the black-browed albatross (*Thalassarche melanophris*; Robertson et al., 2017). Black-browed albatrosses, along with other petrel species, are known for their seasonal use of the inner waters of fjords and channels where hake fishers operate (Arata et al., 2014; Ojeda et al., 2011). Seabird studies in this region have recorded that at least 10 seabird species interact with this fishery, with the black-browed albatross and the southern giant petrel *Macronectes giganteus* most associated with boats (Ojeda et al., 2011).

Studies of early human settlements revealed that Indigenous peoples in Patagonia, such as the Yagans, consumed demersal fishes like *M. australis* (Zangrando et al., 2016) and engaged with seabirds for food, techno-economic supplies, ceremonial and spiritual purposes (Gusinde, 1986; Lefèvre, 1993; Lefèvre & Laroulandie, 2014; Tivoli, 2010). Indeed, albatrosses and other seabirds continue to be part of Yagan oral storytelling (Ojeda et al., 2017). In more recent times, hake fishers, originating from Indigenous and mestizo communities in the Chiloé and Guaitecas territories of northern Patagonia, maintain a positive view of seabirds (Suazo et al., 2013).

Hake fishers employ a highly selective fishing method, resulting in scarce fish discards and associated seabird bycatch due to hooked individuals while feeding on baits (Moreno et al., 2006). The artisanal hake fishing fleet primarily consists of boats ranging from 7 to 10 m in length, powered by 45 HP engines and typically operated by two fishers fishing with drifting longlines, known as 'atorrantes' (wanderers), and other fixed longlines referred to as 'linea madre' (mother line; Moreno et al., 2006). Artisanal operations use high sinking lines to catch hake and hence have very low seabird mortality rates (Moreno et al., 2006). The primary attraction for seabirds in this fishery is by-products like offal items produced during hake gutting, including gonads, liver and stomach (Ojeda et al., 2011).

Despite its overexploitation in other Chilean waters, the Magallanes region still sustains important hake fishing grounds (see Legua, 2021). This overexploitation is mainly due to the current industrial fishing operations (factory trawlers) and the past hake rush, with a peak between 1984 and 1992, which occurred primarily in the Los Lagos and Aysén regions (Morales Pérez, 2012). However, the Magallanes region also presents multiple conflicts related to decision-making processes. For instance, the number of hake fishers has suffered a dramatic reduction mainly due to official regulations such as Individual Transferable Quotas and the drop in purchasing power of hake, triggering political, cultural and economic issues (see Brinck Pinsent & Morales Pérez, 2013; Mellado et al., 2019). Indeed, the hake fishery has a convoluted history in the region, resulting in few fishers remaining active, many of which are unlicensed fishers with informal work (Torres & Ojeda, 2023).

2.2 | Social-ecological methods

With the goal of conducting interdisciplinary research in the practice to provide a common ground for social and ecological research, we explored two lenses to understand reciprocal contributions in the hake fishery: that of hake fishers and seabirds. To assess the hake fishers' lens, we analysed their understanding of perceptions, memories and experiences interacting with the marine-coastal environment, particularly with seabirds. Clearly, we could not interview seabirds about their relationships with fishers, but we could uncover some clues about their food interactions. Thus, we explored the 'seabird lens' through ecological tools to understand interactions with offal consumption and seabird abundance. Given that seabirds are attracted to fishing boats

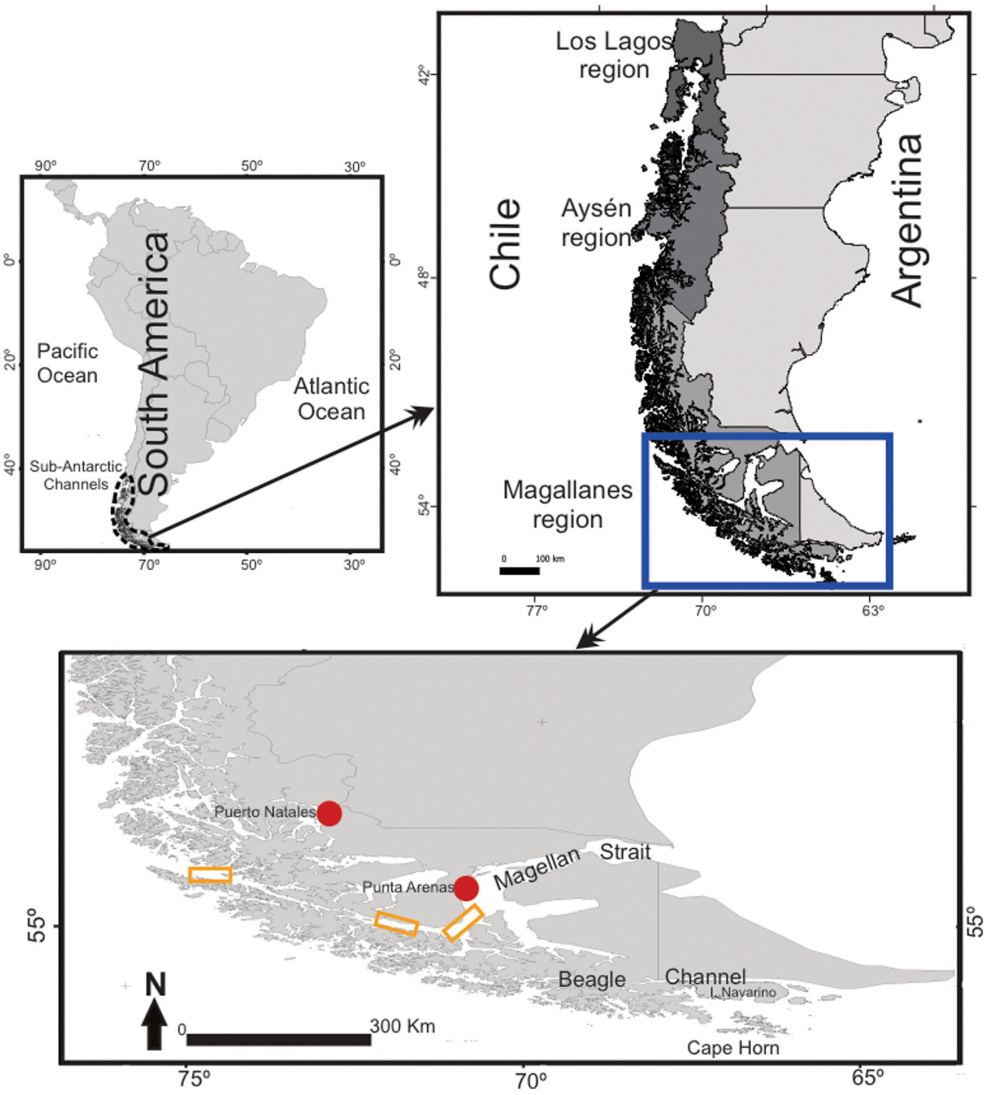

FIGURE 1 Hake artisanal fishery occurs in the sub-Antarctic channels of Patagonia, Chile. This area comprises three political-administrative regions: Los Lagos, Aysén and Magallanes. The blue box shows the study area, the red circles display where the interviews were conducted, and the yellow rectangles show fishing grounds where we ran the sampling periods related to the offal consumption survey.

for the discarded offal, understanding these interactions is crucial for integrating ecosystem-based management strategies that consider both social and ecological dimensions.

2.2.1 | Hake fishers' lens

Two methodological approaches were used. The first component was participant observation, which allowed us to become immersed in the daily routines and practices of hake fishers. We followed active participation (see Jorgensen, 2020), encompassing fishing experiences during two periods: in 2008 and 2019–2021. In these experiences, we navigated, fished and lived in various remote places within the Magallanes region (see Figure 1). Ethnographical notes were meticulously taken on artisanal fishing boats and in fishing huts, known locally as 'ranchos de pesca' (fishing huts). These records were complemented with photographs that captured the fishers' ways of life in marine-coastal environments (see García & Ojeda, 2022). These photos were subsequently shared with the fishers, generating feedback as they interchanged, sharing old photos related to their fishing activities. These experiences and notes enriched the information from semi-structured interviews and permitted us to build a long-term engagement process with fishers.

Our methodological strategy incorporated semi-structured interviews with artisanal hake fishers, conducting 14 interviews in Punta Arenas and Puerto Natales. Initial identification of interviewees used a regional artisanal hake fishers list (Subpesca, 2004), complemented by snowball sampling from established connections (Ojeda et al., 2011), targeting fishers active within the past decade. Considering the historical context surrounding fishing licences, we included both licensed and unlicensed fishers to capture all perspectives on nature-fisher relationships. Discussions encompassed

nature's contributions, including topics such as values of nature (reciprocity), indicators, perceptions about target species (e.g., hake), non-target species (e.g., seabirds) and habitats. We also explored the fishers' contributions to marine environment by delving into memories, practices and experiences related to fishing operations, traditional management and customary uses. Each interview, comprised of 24 open-ended questions, lasted approximately 2 h (see Supplementary Material S1 for interview questions). Before each session, we outlined the project purposes and presented the informed consent form. With the participant's permission, we recorded the interviews and, in some instances, took photographs. The emergence of repetitive information signalled data saturation, indicating a sufficient breadth of topics covered. Interviews were conducted and transcribed in Spanish, from which multiple quotes emerged. These quotes were coded using NVivo 9 software (QSR International Pty Ltd) and later translated into English to make this work more accessible to a broader audience. Our research received ethical clearance from the University of Victoria (ethics protocol number #19-0537).

We analysed interviews using two frameworks: Nature's Contributions to People (NCP) and reciprocal contributions (RC). Both provide multiple perspectives and reference points to understand nature-people relationships. In the coding process, we used as top thematic codes the generalizing view of NCP (see Díaz et al., 2018). We classified the quotes related to the marine-coastal environment's contributions to hake fishers according to 18 NCP categories (child codes) encompassing three dimensions: material, non-material and regulating (see Díaz et al., 2018). Some categories had numerous quotes, while others had none (e.g., in regulating NCP categories). Categories without quotations were excluded from visualizations. We employed the RC to explore how hake fishers manifest and embody values of nature (reciprocity), traditional guidelines and value indicators that are often overlooked in fishing assessments (see Long et al., 2017). This concept (a top thematic code) presents a preliminary list of 21 reciprocal contributions (child codes) across three human dimensions: symbolic-linguistic-cultural, biophysical and institutional-social-political (see Ojeda et al., 2022). Using the preliminary list, we found four categories (food provision, fishing guidelines, ethical values and waste reduction) that emerged in relationship with the hake fishery. The reciprocal contribution concept serves as a driving force for researching positive human contributions to nature. It is also a catalyst for understanding how these positive actions are interconnected with nature's contributions in a circle of mutual aids (Ojeda et al., 2022).

We used NVivo 9 software with both frameworks to categorize fishers' quotes using top codes (e.g., NCP) and child codes (e.g., food and feed). To facilitate visualization, we calculated percentages by contrasting the number of quotes in each top thematic code (e.g., reciprocal contributions) with those in a corresponding child code (e.g., food provision). These percentages, however, should not be construed as numerical descriptors of the cultural significance of hake fishing. Instead, they illustrate that the interviews enabled us to uncover more detailed narratives on certain topics over others. From this, we identified some important indicators in the relationships between hake fishers and seabirds, for example. We recognized that these percentages could be biased by various factors, such as fishers' particular interests, experiences in the last fishing days, role as crew members or our interview questionnaire structure. It is important to note that some responses, or quotes, contained multiple categories, requiring us to use several codes to fully capture the breadth of ideas expressed (Brewer et al., 2017).

2.2.2 | Seabird lens

To research the seabird interactions with hake fishing operations associated with consumption of offal discharges, we focused on two levels: (i) point count surveys of seabird composition and abundance of individual species, along with the total assemblage abundance; and (ii) consumption of hake offal items. Our fieldwork spanned 24 sampling periods (fishing days) during 2008 and 2019–2022, encompassing the summer, winter and autumn seasons and covering various fishing grounds in the Magallanes region (Figure 1).

We determined the composition and abundance of seabirds by employing a fixed count point method from the fishing boat, estimating an arc of 360° with a 100–150 m range from the boat (Bibby et al., 2000). Hudson and Furness (1988) noted that evisceration creates a focal point for seabirds, making identification easier. Thus, we counted when the hauling of the line was finalized, and fishers initiated the evisceration process, generally performed at the end of fishing.

We estimated the overall mean abundance per species and seabird abundance by season, visualized in a heatmap prepared with the 'ggplot2' package (Wickham, 2016). To test for an effect of season on seabird species constituting 95% of the total abundance, we ran an analysis of deviance, followed by a Tukey post hoc test for pairwise comparisons (seasons), using R version 4.2.2 (R Core Team, 2022).

We investigated the probability of the seabird assemblage consumption on specific hake offal items, such as the gonad, liver and stomach. For this study, we defined a seabird assemblage attending a fishing boat in a single sampling period as the total number of taxonomic seabird species, including their abundances. In each sampling period, we randomly threw the offal items one by one from the boat into the sea. Consumption was categorized as '0' if no seabirds consumed an item and '1' if one or more seabirds consumed an offal item. We conducted 24 sampling periods, totalling 1298 observations of item consumption. The binomial positive or null 'offal consumption by seabirds' served as our response variable, and the explanatory variables included 'types of offal' (fixed factor), 'seasons' (fixed factor), 'sampling periods' (random factor) and 'abundance of seabird assemblage' (random factor).

We ran five potential models using generalized linear models (GLMs) and generalized linear mixed-effects models (GLMMs; see details in Supplementary Material S2). To select the most parsimonious models, we utilized Akaike's information criterion corrected for small sample sizes (Burnham & Anderson, 2002). When the selected

model revealed significant effects for specific offal items, and we obtained parameters to calculate the predicted probabilities of consumption by items, estimating their 95% confidence intervals for the explanatory variables. Our analysis used the packages as lme4 (Bates et al., 2015), ggplot2 (Wickham, 2016) and MuMIn (Bartoń, 2023), in the R programming language (R Core Team, 2022).

We employed the SIMPER (Similarity Percentages; Clarke, 1993) analysis to identify which species contributed to consumption by specific offal items. During the sampling periods, we registered both the species and the number of individuals per species that consumed each type of offal item ($n = 1298$ observations). In this procedure, we used the Bray–Curtis similarity measure, calculating it for all pairs of samples within and between groups. We cut off the SIMPER list when the cumulative contribution of species per item reached 90% and ran these analyses in the PRIMER 5 software (PRIMER-E, Ltd., Plymouth, UK).

Finally, we performed a proximate analysis on hake offal items to determine the macronutrient composition on hake's stomach, gonad and liver. For this, we preserved five whole pieces from each type of offal on ice, then dissected them into sub-samples in the laboratory and stored them at −20°C. Subsequently, we defrosted the sub-samples to conduct analyses of their proximate composition, determining their protein, moisture, ash and lipid (fat) content. The methods employed for analysing the crude protein, moisture, ash and lipid content adhered to the standards set by the official methods analysis (AOAC, 2000). We calculated the carbohydrate content by subtracting the total sum of protein, lipid, moisture and ash from 100 and reported this as nitrogen-free extractives on a dry matter basis. Additionally, we computed the energy values of the gonad, liver and stomach using Atwater conversion and expresses as kJ (Merrill & Watt, 1973).

3 | RESULTS

Hake fishers' relationships with the marine environment, particularly with seabirds, are multidimensional. We identified seven categories of Nature's Contributions to People (NCP) that underscore the importance of the ocean for hake fishers, where categories as 'learning and inspirations' and 'materials, companionship, and labour' contained many detailed quotes (Figure 2; Table 1). For example, fishers value their capacity to learn about spatial movements, considering fishing grounds, depths and seasonal changes. This ecological knowledge is related to their fishing effort and is an indicator of having better fishing productivity. We also emphasized that most fishers valued their labour with hake because it allowed them to raise and educate their children, contributing to family prosperity and human wellbeing.

However, the hake fishery presents multiple conflicts related to decision-making processes and telecoupling factors. Due to the globalized hake market, the economic crisis in Spain (2008–2014) impacted the purchasing power of hake. This issue was combined with the monopsony of the hake market that fishers have faced in the Magallanes region, causing social-ecological cascading effects. Due to the drop in purchasing power of hake, from 2012 onward, the Chilean fisheries agency (SUBPESCA) implemented an amendment to fishing law 19.923 (Mellado et al., 2019), allowing for the transfer of quotas from artisanal fishing licence owners to industrial operators. This political arrangement enabled industrial boats to fish for hake offshore, using the artisanal quota, in exchange for payment on a per-kilo basis. This regulation contributed to a decrease in the number of artisanal fishers. In our experiences on boats and interviews, we repeatedly listened to the same statement: '*We are the last generation of hake fishers*' (see details in the Supplementary Material S3). Loss of purchasing power and new fishing policies have resulted in job losses and deterioration of biocultural continuity, values of nature and the contributions of marine life to people. While Supplementary Material S3 offers comprehensive narratives and memories about nature's contributions to fishers and conflicts, we focus on the complexities of the seabird-fisher relationship in the subsequent paragraphs.

3.1 | Fishers–seabird relationships

In our interviews, narratives showcased the multidimensional interactions between hake fishers and seabirds, spanning six NCP categories across regulating, material and immaterial dimensions. Regulating dimensions embrace ecological narratives described in 'learning and inspiration' and 'regulation of detrimental species and biological processes' categories (see Table 1). Most fishers indicated that seabird aggregations were relevant ecological indicators for finding sardine shoals (Table 1; details in the Supplementary Material S4). Fishers often attributed the value of marine cleaning to seabirds. As Antonio Tureman recalled from childhood, '*The seagull was an integral part of our system for cleaning the coast*'. At sea, albatrosses and petrels are well-known scavengers whose contributions are highly valued by fishers (see Table 1). Fishers also perceive that seabirds can inadvertently attract sea lions to fishing grounds by making noise when they discard hake offal while hauling the longline, an indirect interaction that could have detrimental effects. As a result, fishers often choose to gut hake after finishing the line haul. There are three strategies for managing offal that are not mutually exclusive: (i) retain the offal in a pail, (ii) throw it while navigating from the fishing ground to the cove or (iii) discard it near the coast; for example, a near kelp forest where the boat is less exposed to wave action.

The value of seabird companionship intertwines psychological experiences, fishing identities and reciprocal relationships with fishers. All participants in our interviews recognized seabirds as culturally important species during their marine work. These companions alleviate the loneliness of long working days and contribute to a sense of place within the marine environment (see companionship in Table 1; Figure 3c). As Juan Colguan shared, '*What happens is, if there's no wildlife nearby, it can bring you down. But if there's a bird flying around, your attention is drawn to it, and you become focused on observing its actions*'. Throughout our interviews and fieldwork on

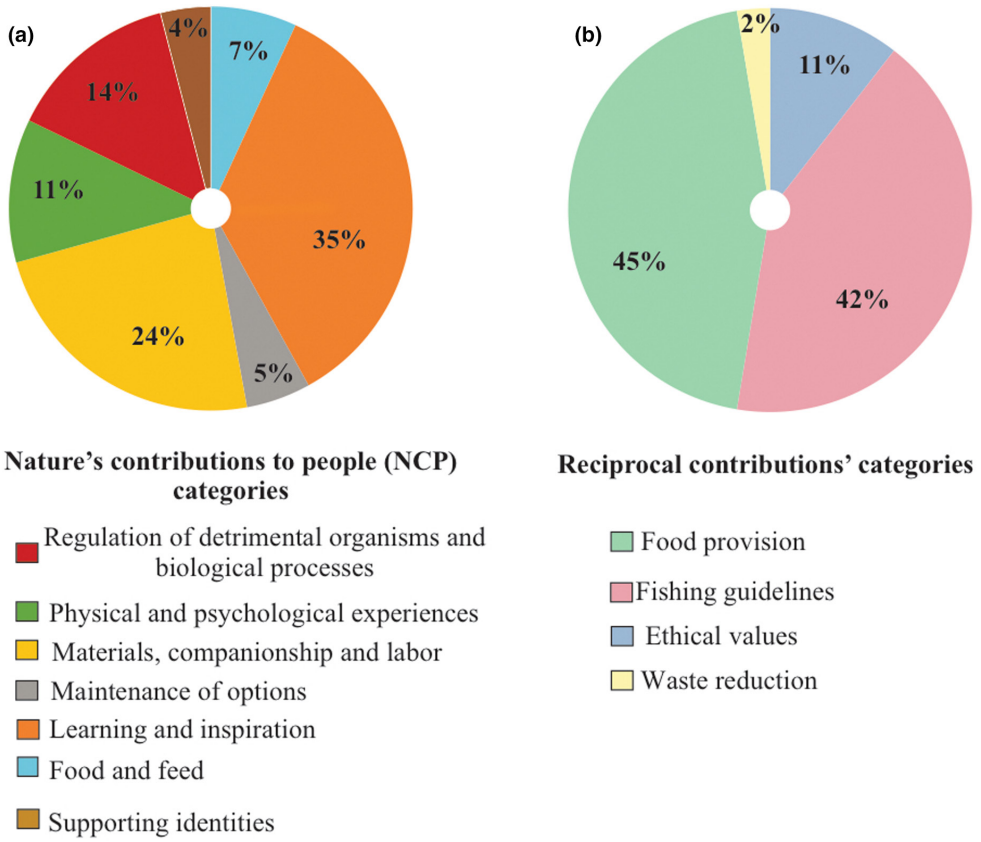

FIGURE 2 (a) Percentages of fishers' quotations linked to the contributions of marine-coastal environments, including seabirds, to hake fishers, categorized by nature's contributions to people (NCP). (b) Includes all quotations related to positive actions, interactions and experiences of fishers with their marine environment, including seabirds. These positive relationships are classified using the reciprocal contribution framework. Percentages were calculated with the total quotes of fishers categorized in a top thematic code (e.g., reciprocal contributions) versus the number of quotes categorized in a child code (e.g., food provision).

boats, we noted instances of fishers talking with albatrosses or enjoying seabird behaviour (see psychological experiences in Table 1). The presence of seabirds during fishing activities also serves as a crucial indicator of marine health. As Manuel Mancilla put it, '*They [seabirds] are a sensation that there is life in our daily experiences at sea…. it's strange if you go out to the middle of the sea to work and don't see any birds. So, it's strange if there's no movement*'. These ecological and psychological interactions underline how biocultural memories and the principle of reciprocity cultivate a sense of place and enhance a holistic understanding of marine health and fisheries management.

We identified three categories in which hake fishers contribute to seabirds, thereby maintaining the reciprocal loop of contributions between the two (Table 2). The value of respect that fishers hold for seabirds is often fostered by a companionship sense (see ethical values in the Table 2). Seabird companionship can embrace a kinship notion and aesthetic value. For instance, Juan Maldonado views himself and seabirds as marine hunters that look for food and sustenance. He stated, '*Honestly, I let them [seabirds] eat because it's their food chain. We're the ones taking away their food, but we are also hunters*'. We noticed fishers photographing seabirds, mainly albatrosses, during our fieldwork. Although it is uncommon in fishing operations, when it does occur, photographs can be driven by the intrinsic beauty of seabirds. Enrique Vera stated, '*I respect all living beings. I like birds… It's beautiful to see them, especially when they're nearby—it's lovely. I often take photos… I enjoy it; I constantly share pictures of the albatrosses… I take their pictures because I love to watch them*'.

Hake fishers have adopted some fishing guidelines with the dual objectives of reducing seabird bycatch and enhancing fishing efficiency. The ecological knowledge about where, when, and how to fish has mutual benefits: Be selective and reduce fishing effort and bycatch. For instance, the use of medium-sized boulders as weights is acknowledged for increasing the sink rate of fishing lines, noted as an important feature of the fishing gear to reduce seabird bycatch (Figure 3a). In addition, fishers use sticks to deter seabirds from approaching hooks (Figure 3d). This method not only prevents damage to the bait but also minimizes the risk of seabird bycatch. Generally, fishers try to avoid seabird bycatch as it can interfere with fishing operations by causing entanglement of longlines and impact on the gear performance and fishing success.

The most significant perceived contribution of fishers to seabirds involves the provisioning of food through hake offal consumption (see Table 2; Figure 3e). All fishers view this practice as a positive interaction—whereby they provide food and, in turn, seabirds clean the sea.

TABLE 1 Illustrative quotes from hake fishers that highlight marine-coastal contributions, categorized according to the Nature's Contributions to People (NCP) framework.

NCP categories	Interactions with marine-coastal environment	Seabird interactions
Food and feed	We used to smoke fish. Enthusiastic people like to smoke fish to bring home. We built smokers, and this way, they [fishers] would bring their fish home (Antonio Tureman)	It's not common [to eat seabirds]. To begin with, not everyone ate them. We didn't kill them. They sometimes ended up hooked and we couldn't get them off, and they went under [drown] with the hooks [...] We took out the breasts, the legs because those are the only parts where there's meat. You filleted it, cleaned it well, then boiled it with some onion (Antonio Tureman)
Learning and inspiration	Hake goes deep in winter until September, and then they rise. Later, we discovered that there were many places in the Magellan Strait [with deep fishing grounds]. The Otway Sound, it's also nice for fishing, it's shallow, but in the summer, there are fish (Juan Maldonado) In the past, the Jurel [Chilean jack mackerel] would come to the shore to find food, but the hake wouldn't, not during the day. You don't catch hake during the day at the surface, but at night, yes. At night the fish would come up, the Jurel, the Sierra [snoek] would appear, as well as the Huilcas [hoki] (Marcos Leal) The old folks used to primarily work with the tides or the moon. For instance, the older fishers wouldn't go fishing during a full moon because it was bad. They would say it was bad because, with a full moon, the fish wouldn't come close to shore (Antonio Tureman) The hake is a deep-water fish, as are the demersal species [...] If we fish in the summer, the fish will be about 80 m, 100 m deep. If we fish in winter, it will be at 300 m, and if we fish in the fall, it will be at 180 m. There's a seasonal change (Erardo Muñoz)	Seabirds indicate where my fishing spot is; you could say my food. For example, if I see a school of fish with a flock of birds, it can be inferred that they are feeding there and there are sardines. Thus, I could say they assist me in my daily tasks of knowing where the sardines are moving or shrimp... and that way, I can get my bait (Manuel Mancilla) If there is, for example, a group of seagulls or Pachancas [penguins] all together in certain areas, it's because there's a school of fish below. For sure, it could be sardines... And that's natural; we all know it. And that's what we call a Pajarada 'bird gathering' (Erardo Muñoz)
Maintenance of options	For instance, if you take an inexperienced person and you're going to teach them. That person will come to love fishing [...] When I took youths for fishing, who didn't yet know, I told them: 'no one was born knowing, my friend... I will teach you how I started working by observing how others did it'. (Antonio Tureman)	
Materials, companionship and labour	We brought chainsaws, nylon, nails, wood burners, and generators. And outside, we made our fishing huts [ranchos] with nature, with the trees. We made a frame of a house but with just rods (Fernando Aguilar) Tepú [*Tepualia stipularis*] is good firewood. Up there in a spot behind the Ventura channel, that's where we were working. We would go to get Tepú there. One recognizes Tepú by its branches and thick sticks only... I always wondered why Tepú burns so much? [...] You throw it into the fire, and in a little while, there's very hot (Marcos Leal) I do it with love [fishing]. It gives me everything [the sea]. This work gives me satisfaction, and it gives me the money to survive. So, it means everything. Imagine how unhappy I'd be working in a city, working 8 h in a routine. Besides, I wasn't born to be bossed around, I don't like it, and that's why I sought this job. Of course, being in contact with nature that's the most beautiful thing (Enrique Vera)	But honestly, I let them [seabirds] eat because it's their food chain. We become who are taking away their food, but we are also hunters. So, they [seabirds] don't bother me. On the contrary, I think it's satisfying to find birds beside one because it feels like there's more life; you're not alone... Sometimes you talk to them because it's like another living being next to you (Juan Maldonado) Birds are a companion because they also distract you from loneliness by allowing you to see that there truly is life. Because it's strange if you go out to the middle of the sea to work and don't see any birds, you don't see anything. So, it's strange if there's no movement (Manuel Mancilla)
Physical and psychological experiences	The sea ensnares you and doesn't let you leave. So, you start to lose all your youth. You don't live like people working in the city: getting home, taking a shower, watching TV, going out with a girlfriend. In fishing, we didn't live that. It's a long time; you could sometimes be out for a year without going to the city (Erardo Muñoz) I find satisfaction in the sea. I would sleep on the islands at night, in a different vibe, at peace. But the sea has taken a lot of my friends. It's the law we have; it's what happens to us. (Juan Maldonado)	To me, they catch my attention. The thing is, if there's no little animal nearby, it gets you down. But if a bird is flying around, you pay attention to it and focus on watching what they're doing (Juan Colguan) There are birds that also make you laugh because sometimes they steal food from each other, and there are things that make you laugh (Manuel Mancilla)

TABLE 1 (Continued)

NCP categories	Interactions with marine-coastal environment	Seabird interactions
Regulation of detrimental organisms and biological processes	Today, the sea lion is already adapted to eating from man's hand, not hunting [...] What the sea lion does is check [...] it gets used to working the longlines and is going to fishing areas and already knows where are the longlines (Manuel Mancilla) If I leave the longline down there in the depths, working at more than 300 m, there are a lot of sharks. So, they eat the hake completely, leaving only the head (Manuel Mancilla)	The positive thing is that they [birds] eat all the guts. The sea does not get so dirty, and what they don't manage to eat, fishes eat in depth, but they [birds] clean the sea a bit (Marcos Leal) If I catch a fish and start to gut it, they [seabirds] start to make noise, and the sea lion hears [...] If the birds don't make any noise, no sea lion arrives [...] When we get near the shore, we prefer to gut the fish... We must seek balance (Enrique Vera)
Supporting identities	Artisanal fishing is my profession because, in essence, we are professionals of the sea in artisanal ways. It has also been my social part; I raised my children with artisanal fishing (Erardo Muñoz) It's not that one arrives and throws a longline in deep waters to catch a hake. We devise a way to search the depths to where they are [...] So, we look for the fish and learn over the years (Juan Maldonado)	Birds have been a part of our life. From the start, they have always been a part of one's life in fishing (Antonio Tareman)

Note: Here and in the body text and other tables, we used the symbol '[...]' when necessary to shorten sentences. If slangs or other expressions unrelated to hake topics were present in the original quote, they were shortened to better illustrate the main point in the quote.

Hector Ruiz noted, '*In essence, it was beautiful to see so many birds feeding because they were actually consuming the waste, we discarded from the hake guts*'. Fishers remarked that seabirds, particularly albatrosses and petrels, exhibit selectivity when consuming offal items; their preference is the liver (Figure 3f). This observation is described by Enrique Vera's quote in Table 2 (see 'food provision' category). In addition, he added, '*I believe that* [consuming hake liver] *keeps them warm because the "pana" provides the calories they need, so they don't get cold. The birds, even in the middle of winter, when it's so cold, they're bathing, almost as if they're flaunting it*'. The term 'pana' comes from Mapudungun (Mapuche language) and means 'liver' (Villena Araya, 2017).

3.2 | Seabird lens: A closer look at ecological interactions

We identified 11 seabird species associated with the artisanal hake fishery (Figure 4a). Four species: the southern giant petrel (*Macronectes giganteus*), kelp gull (*Larus dominicanus*), black-browed albatross (*Thalassarche melanophris*) and the Chilean skua (*Stercorarius chilensis*) comprised 95% of the total abundance. We observed seasonal variations in seabird occurrence and abundance. For instance, the southern fulmar (*Fulmarus glacialoides*)—an Antarctic breeder—was absent throughout the summer sampling periods, while during the winter and spring, it showed mean abundances of 6 ± 2.5 and 1.2 ± 0.4 individuals per sampling period, respectively (Figure 4b). Regarding seasonal abundance, the Chilean skua and black-browed albatross exhibited significant variation, primarily more abundant in the spring and summer when compared to winter ($p < 0.05$; Figure 4b). It is noteworthy that the Chilean skua was observed only once during the winter sampling periods, whereas the black-browed albatross reduced its abundance in winter but was present throughout all seasons and all sampling periods. The southern giant petrel and the kelp gull were present during the entire study and did not show significant seasonal variation.

Based on the Akaike information criterion, we identified two models that effectively explained the consumption of hake offal by seabirds, collectively accounting for 84% of the model weight (see Supplementary Material S2). Both models indicated that the type of offal items significantly influenced consumption ($p < 0.05$). Following the principle of parsimony, we selected Model 4, which evaluates 'offal consumption by seabirds' (as the response variable) in relation to 'types of offal' (as the fixed factor) and 'sampling periods' (as the random factor; see Supplementary Material S2). This model indicates that 'liver' has a high probability of consumption, reflected by a logistic regression coefficient of 5.3. In contrast, the item 'stomach' had a coefficient of −1.3, indicating that the consumption probability decreased with this item. Using this model, we illustrated the probability of consumption for each item, showing that the seabird assemblage is almost certain to consume the liver (ca. 100%), whereas the chances of consuming gonads and stomachs are 55% and 24%, respectively (see Figure 5a).

Our SIMPER analysis showed how the type of offal influences the kind of seabird species that participate in the consumption. Southern giant petrels (61.4%) and black-browed albatrosses (28.6%) primarily consumed liver throughout all sample periods (see Figure 5b). Conversely, stomach items were not consumed in every sample period; however, when they were present, kelp gulls (60.6%), black-browed albatrosses (23.6%) and Chilean skuas (15.6%) mainly contributed to this consumption (Figure 5b). In some cases, the black-browed albatross consumes hake gonads, but we observed that Chilean skuas actively feed on these when the albatross does not. These ecological data aligned with our field observations conducted onboard. For instance, we noted different behaviours of seabird species when attending artisanal hake operations. The southern giant petrels and black-browed albatrosses mainly fed through surface seizing, paddling, and waiting for the offal discard, with a primary focus on liver selection. In contrast, kelp gulls and Chilean skuas show more aerial interactions, often resorting to aerial piracy and dipping. Therefore, their access to offal items such

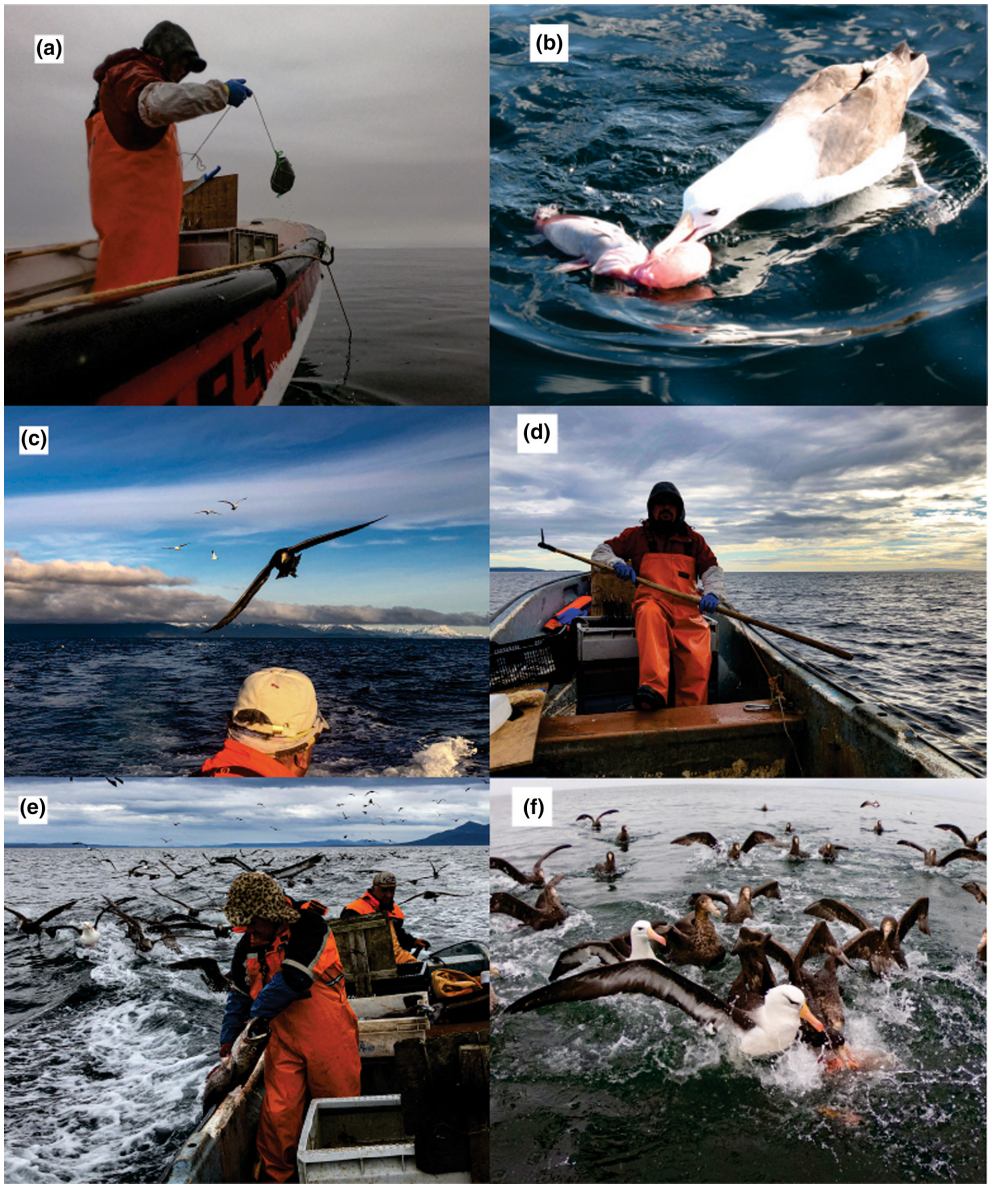

FIGURE 3 This panel depicts various fishing activities that involve interactions between fishers and seabirds. (a) Displays the longline setting that employs a medium-sized boulder to increase the sink rate. (b) Reveals a brotula with its stomach everted due to pressure fluctuations, resulting in fishing line buoyancy that attracts seabirds to the caught fish. (c) Illustrates encounters between fishers and seabirds that can lead to positive psychological experiences. (d) Exemplifies the application of fishing guidelines during the setting operation, where fishers use a stick to scare away seabirds, thus preventing damage to bait and accidental seabird bycatch. (e) Depicts a fisher gutting a hake and discarding offal, which is then consumed by seabirds. (f) Depicts the appeal of hake liver as a food source for southern giant petrels and black-browed albatrosses. Photographs were taken by Jaime Ojeda.

as gonads and stomach contents might be overlooked or disturbed by the abundance of larger southern giant petrels and black-browed albatrosses positioned closer to fishing boats. Moreover, we noted that southern giant petrels and black-browed albatrosses frequently rejected stomach or gonad items, leaving them for potential consumption by kelp gulls and Chilean skuas. However, this opportunity is challenging because offal items start sinking amidst the numerous southern giant petrels and black-browed albatrosses. Consequently, waiting to access offal has its limitations due to the sinking factor.

Proximate analysis on offal items provides insights into why liver is particularly important for seabirds: hake liver contains, on average, 51.6% fat whereas the gonad and stomach contain only 3.8% and 1.3%, respectively. These results reflect a significant difference in the amount of energy provided by these offal items (Table 3). For instance, 100 g of liver holds 2076.7 kJ of energy, while the same quantity of gonad and stomach can just offer 365.5 and 310.2 kJ, respectively. Thus, hake liver serves as an available energy source six–seven times higher when compared to other by-products simultaneously discharged from this fishery. These proximate data not only corroborate fishers' perceptions and their ecological knowledge of seabird behaviour upon the discarding of hake liver from fishing boats, but also support ecological observations of offal consumption

TABLE 2 Hake fishers' illustrative quotes that embrace positive actions, interactions and experiences of fishers with the environment, including seabirds.

Reciprocal contributions	Fishing environment	Seabird interactions
Ethical values	I respect all living beings. I like birds and marine animals [...] It's beautiful to see them [albatrosses] [...] I take pictures of them because I enjoy watching them (Enrique Vera)	For instance, nowadays, some people kill a seagull, and we didn't do that in the past because the seagull was part of your system to clean the coast. For example, if you throw a piece of fish, the seagull will eat it [...] there was a kind of respect for the birds (Antonio Tureman)
Fishing guidelines	We, as artisanal fishers, are selective because we work with longlines. Always, there is a comparison: Who causes more harm? Artisanal or industrial fishing? How does the industrial fishery catch? They trawl [...] Our method is rustic [...] we put a stone, a monofilament, hooks, baits, a small buoy, a flag, and our hands. That's our fishing method (Juan Contreras)	Sometimes, you have to be there with a stick, with a rag so that they don't eat the bait [and don't get caught on the hook] (Yanet Muñoz)
Food provision	When I was a child, I had a pair of semi-domesticated seagulls. They followed me to the place where I fished. They fluttered around until I caught the first fish [...] First, I gave them fish guts so they could eat, and then they calmed down. Always, I started by feeding my seagulls (Antonio Tureman)	We don't harm the birds. On the contrary, we eviscerate fishes [hake] and throw their guts to feed birds. Here, if you throw something, the birds immediately eat it; they clean the sea (Hernan Jiménez) The only thing they eat is pana (liver). You throw hake stomach, and they don't eat it. I scold them [seabirds], hahaha. I ask them, why do you only eat pana? Look, I left some of the guts and roe here for you (Enrique Vera)
Waste Reduction	Perhaps, I am a small link in the sea's chain, but there must be a starting point to help protect the coasts by not throwing trash... I tell my fellows not to do it, but some are rather stubborn and throw [trash] anyway. So, I think that's one of the ways I could give something back to the sea (Juan Maldonado)	

Note: These positive relationships were classified using the reciprocal contribution framework.

by seabirds, particularly by southern giant petrels and black-browed albatrosses.

4 | DISCUSSION

4.1 | Reciprocal contributions

This study demonstrates that while seabirds offer diverse contributions to people, artisanal fishers' perspectives toward seabirds are rich with reciprocal contributions. For instance, from a hake fishers' perspective, we identified that fishing in the right way can minimize bycatch, and fish offal can contribute to seabird diets. In return, seabirds offer a variety of benefits, including companionship, aesthetic value, sea-cleaning services and function as a fishing ground indicator. From a seabird view, some species have seasonal changes like Chilean skua and southern fulmar. In turn, seabirds, such as southern giant petrels and black-browed albatrosses, preferentially consumed hake liver over other offal items. These findings reveal the importance of addressing reciprocal contributions as a catalyst for a dual understanding of fishers' relationships with marine life.

This dual approach has the potential to refine methodological practices in fisheries research. We encourage social-ecological researchers to engage with fishers and explore questions related to the fishers' potential contributions to marine life. These questions could address how their fishing activities might benefit other marine components or

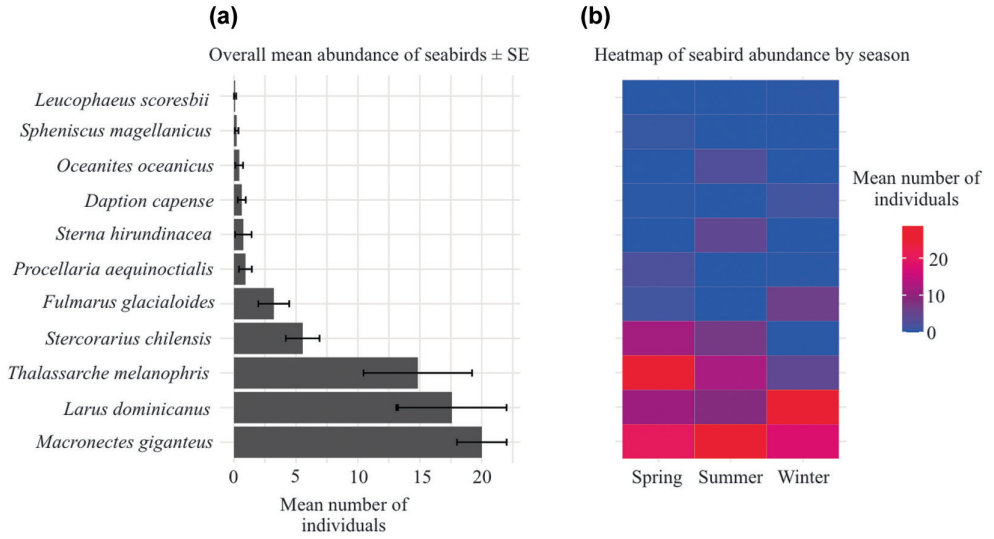

FIGURE 4 Seabird species associated with artisanal hake fishing boats. The bar chart (a) presents the total mean abundance of each species, expressed as mean ± standard error (SE), observed across all sample periods ($n = 24$). The heatmap (b) demonstrates the mean seasonal abundance of each species, providing a visual representation of their distribution across different seasons.

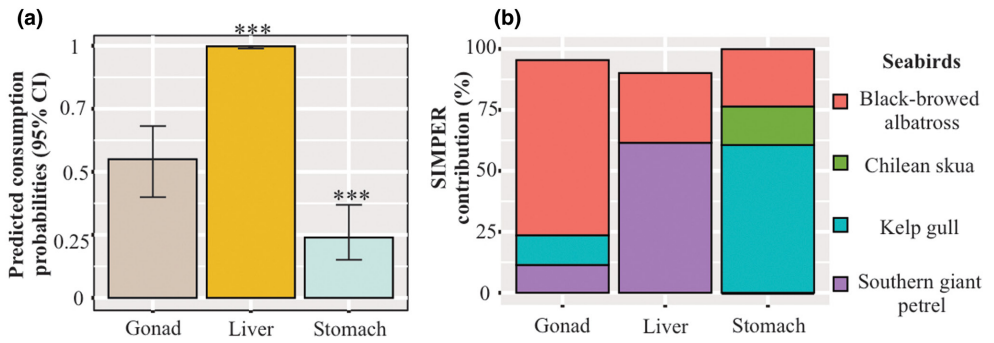

FIGURE 5 Ecological analysis of offal consumption by seabirds. (a) Predicted probability of offal consumption by seabirds. This probability was estimated with a 95% confidence interval (CI) using Model 4, which evaluates 'offal consumption by seabirds' (the response variable) in relation to 'types of offal' (the fixed factor) and 'sample periods' (the random factor). Asterisks denote significant effects: The liver item significantly increases the probability of offal consumption by seabirds, while the stomach significantly decreases it ($p < 0.05$). (b) SIMPER contribution analysis of offal items (gonad, liver and stomach) across all sample periods. The contribution limit was set to stop when the accumulated contribution of seabird species reached 90%.

TABLE 3 Proximate composition of offal items (gonad, liver and stomach) from southern hake (*Merluccius australis*) caught in this study.

Offal items	Moisture	Ash %	Protein %	Fat %	Carbohydrate %	Energy (kJ)
Gonad	81.6 ± 0.3	1.36 ± 0.2	12.9 ± 0.8	3.8 ± 0.4	0.30	365.5
Liver	40.0 ± 0.2	0.50 ± 0.2	7.07 ± 0.3	51.6 ± 0.3	0.83	2076.7
Stomach	81.8 ± 0.4	1.28 ± 0.1	15.2 ± 0.7	1.3 ± 0.5	0.44	310.2

Note: The proximate composition (%) and energy in kilojoule (kJ) were based on biomass in g per 100 g sample ($n = 4$). Data are presented as mean ± standard error.

how their fishing practices are motivated by specific values of nature, such as reciprocity, responsibility and respect. Responses may range from none to complex narratives that encapsulate memories, current experiences, and future intentions concerning marine life. Such diversity in responses could significantly inform decision-making processes and fisheries management strategies. For example, this methodology could complement ecosystem-based management, a holistic strategy that transitions from managing target species alone to adopting a broader ecosystem perspective. This approach integrates ecological, societal and governance principles (Long et al., 2015; Pikitch et al., 2004). In this context, for instance, we identified that seabird consumption of hake liver is an important biophysical indicator of the relationship between hake fishers and seabirds. This phenomenon is closely tied to the cultural dimension because fishers appreciate their

food contribution to seabirds. Indeed, fishers recognize seabirds as fellow marine hunters and value their participation in the ecosystem. In parallel, a social dimension has led to the development of fishing guidelines, such as timing the gutting of hake to take place at the end of the haul of lines, thereby reducing potential damage to the catch from seabirds and sea lions, a matter of concern among small-scale fisheries (Suazo et al., 2024). Despite existing gaps in integrating fishers' values and knowledge of the marine ecosystem into management strategies (Long et al., 2017), this dual approach promotes a comprehensive and balanced integration of ecological, cultural and social factors in fisheries management.

4.2 | Fish offal and seabirds

Human activities can inadvertently boost certain species, leading to negative ecological consequences often associated with large-scale operations. Research on seabird interactions with fishing food subsidies has primarily focused on industrial fisheries, where large volumes of offal discharges and fish bycatch can create ecological traps for seabirds via access to alternative food sources (Løkkeborg, 2011; Votier et al., 2004). These traps result in increased bycatch and artificially boost populations of scavenger seabird species (e.g., Furness et al., 2007). In the Southern Ocean, trawlers can lack selectivity for target species, leading to a high proportion of secondary fish catch. This issue can increase discard and seabird mortality rates due to collisions and entanglement with warp and net monitoring cables (Suazo et al., 2014). Additionally, factory longline vessels pose significant risks, as seabirds often become bycaught when they attempt to feed on buoyant baited hooks (Løkkeborg, 2011). In contrast, this is the first study that explores the offal discharges in artisanal fisheries. A more refined ecological trophic assessment could offer further insights into the pros and cons of this food subsidy in artisanal fisheries, but we emphasized that from hake fishers' perspective, this food provision occurring at small scales and with reduced negative effects for non-target species has a positive contribution to seabirds.

We showed that the hake liver can constitute a soft, fatty and high-energy component of the food landscape on Procellariforms like albatrosses and petrels. Regrettably, such components often go undetected in seabird indirect dietary studies like regurgitates that include gelatinous prey like jellyfish for albatrosses (Suazo, 2008). Fatty components might be relevant during the guard stages in the austral summer when seabirds like southern giant petrels and black-browed albatrosses have a restricted home range due to parental care of broods (Robertson et al., 2014). This seasonal distribution may facilitate their visits and abundances in the inner sub-Antarctic channels (Ojeda et al., 2011).

4.3 | Barriers and future pathways

Such as numerous studies in Latin America (e.g., Mellado et al., 2019; Villasante et al., 2022), our investigation revealed that the artisanal hake fishery has been swayed by neoliberal policies such as Individual Transferable Quotas together to shock and telecoupling drivers. This fishing policy exacerbated divisions among fishers, distinguishing between licensed and unlicensed fishers. The shock driver was Spain's economic crisis, causing cascading social-ecological effects. For example, the Chilean fishery agency (SUBPESCA) allowed the sale and transfer of quotas from artisanal to industrial fisheries (Mellado et al., 2019). The most pressing issue in the Magallanes region is the dwindling number of artisanal hake fishers, leading to an increasing disconnection from the marine environment (García & Ojeda, 2022). In our interviews, a recurrent statement of fishers was: '*We are the last generation of hake fishers*'. This reduction in artisanal fishing activity not only disrupts the transmission of indigenous and ecological knowledge to subsequent generations but also has profound implications for the marine ecosystem, local economies and food heritage (Mellado et al., 2019).

The hake artisanal fishery needs a revitalization plan that incorporates values of nature but also social-economic strategies, such as short commercialization circuits by developing local markets. This strategy of commercialization emphasizes fresh food trade within local contexts, fostering strong relationships between producers and consumers (Buenaventura et al., 2021). These socioeconomic relationships connect people to local food sources and highlight the ecological and cultural significance within local communities (Ibarra et al., 2023). A promising avenue to reinforce this connection is enhancing the local market's purchasing power for hake. By doing so, citizens could gain access to local products rich in nutritional value and participating in preserving a tapestry of ecological interactions and nature values as reciprocity. In the Magallanes region, governmental institutions, which are substantial food buyers like schools and hospitals, could spearhead this initiative. By prioritizing the purchase of local hake, these institutions can catalyse a ripple effect: Ensuring the continuity of traditional fishing practices, enhancing seabird-fisher interactions and ultimately strengthening the sustainable and culturally relevant management of the hake fishery.

Finally, we suggest that both NCP and RC frameworks can serve as methodological tools for investigating the multidimensional relationships between humans and nature. Our study underscores the value of employing dual perspectives to identify diverse values of nature, with a particular emphasis on reciprocity. By listening to fishers and observing seabirds, we uncover narratives, experiences and value indicators crucial for fisheries management at the southern tip of South America. Our findings, therefore, advocate for an inclusive approach to fisheries management that acknowledges and integrates diverse values ascribed to nature.

AUTHOR CONTRIBUTIONS

Jaime Ojeda, Cristián G. Suazo and Natalie C. Ban worked on the conceptualization; Jaime Ojeda conducted interviews in Patagonia. Jaime Ojeda, Flavia Morello, María S. Astorga worked on the ecological surveys and analysis. Jaime Ojeda led the writing of the manuscript and the methodological analysis with the support of Natalie

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CONFLICT OF INTEREST STATEMENT

The authors have no conflict of interest to declare.

DATA AVAILABILITY STATEMENT

The statistical models of seabirds' preferences on hake offal are provided in the Supporting Information. The data associated with this article are available on the Open Science Framework platform: https://doi.org/10.5061/dryad.ngf1vhj3r.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Appendix S1: Semi-structured interview guide for small-scale hake fishery.

Appendix S2: Models.

Appendix S3: Nature's contributions to hake fishers.

Appendix S4: Seabirds' contributions to hake fishers.

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